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Simulations of wide angle tail radiosources

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Abstract. Following previous analyses of the propagation of AGN jets in the three-dimensional Hydrodynamic and Magneto-Hydrodynamic limits, we extend the numerical investigation to the Relativistic Magneto-Hydrodynamic regime, to include sources, different from the Fanaroff-Riley II class, that show jet-counterjet asymmetries in the observed fluxes due to Doppler boosting effects. We consider weakly relativistic, underdense, supersonic jets that propagate in a stratified medium.

1. Introduction

The numerical calculations carried out with the Marconi HPC under the account INA17_C4B23 are connected to a research program that aims to explore the properties of the jets of low-power extragalactic radio sources of Fanaroff-Riley I type in terms of their main physical parameters, namely: jet velocity, density, temperature and magnetic field intensity. The program began in the 2015 and in still under way. A first paper (Massaglia et al. 2016) concerned the study of the propagation of supersonic jets in the hydro-dynamical limit, while a second paper (Massaglia et al. 2019) concerned the effects of the jet magnetization.

In a third paper of the series we extended the analysis to the case relativistic jet velocities (Massaglia et al. 2020), and the computations have been carried out under the account INA17_C4B23, in object.

2. Results

We presented 3D relativistic magneto-hydrodynamic simulations of jets propagating into a stratified medium. We considered three cases with prescribed magnetic field at the injection and different Lorentz factors and density ratios. In all cases the jets produced a FR II-like morphology during the early stages of the propagation, up to distances of about $10 - 20$ kpc from the injection boundary, in agreement with Papers I and II. However, the subsequent evolution lead to substantially different morphologies.

The first simulation, case A, has a similar (low) kinetic power of the MHD cases of Paper II, but with a lower density ratio and a higher velocity. The evolution was very similar to that presented in Paper II, the jet was disrupted by magnetic instabilities at a distance of about 12 - 14 kpc, the flow appeared strongly decelerated and highly turbulent.

The higher power case B maintained an FR II morphology until reaching 40 kpc, but eventually non-axially symmetric MHD modes succeeded in disrupting the jet. In order to establish the physical origin of the modes that decelerate and disrupt the jet we have performed a simulation in the HD limit with the same parameters of case B. We showed that in this case the transition to turbulence happened in a com-

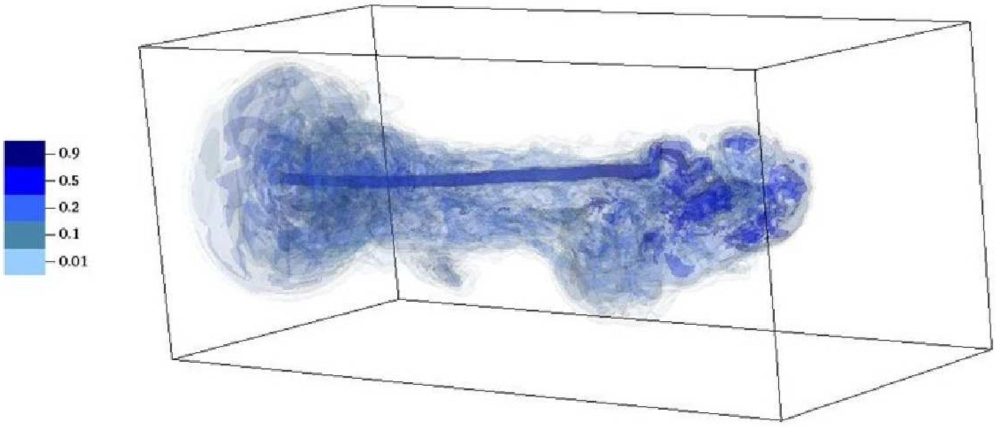

Fig. 1. Three-dimensional iso-contours of the tracer distribution for case A, the size of the computational box is $8 \times 20 \times 8$ kpc.

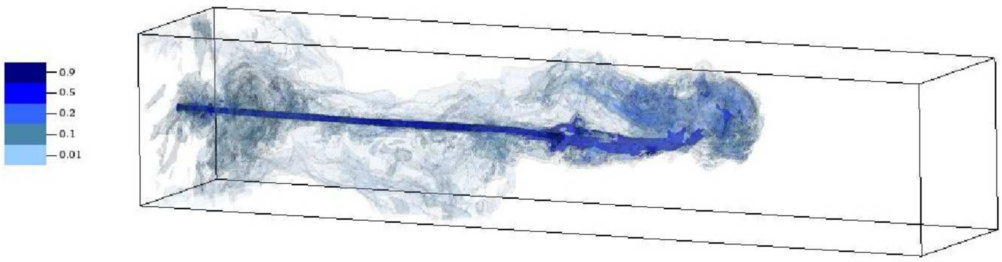

Fig. 2. Three-dimensional iso-contours of the tracer distribution for case B the size of the computational box is $10 \times 50 \times 10$ kpc.

pletely different way as in case B, i.e. without non-axial oscillations signature of magnetic driven modes.

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